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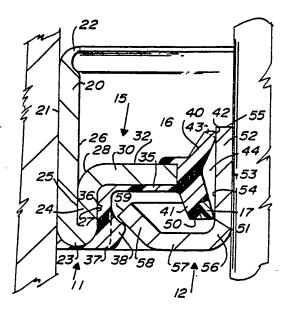
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(54) Title: UNITIZED DUAL-LIP SHAFT SEAL

(57) Abstract

A unitized grease seal (10). The seal member has a one-piece metal case (15), a molded elastomeric member (16) bonded to the metal case (15) and providing a series of spaced-apart inwardly extending retaining portions (38). The elastomeric member (16) also has two diverging lip portions (40-41) with a cavity (44) between them, one providing a grease retention lip (40) having small spaced-apart shallow indentations (43) enabling passage of small amounts of grease into the cavity (44), the other lip (41) portion having a polytetrafluoroethylene insert (17) bonded thereto. A onepiece metal wear sleeve member (12) has a shaftengaging cylindrical portion (52) engaged by the lips (40-41) and a radially outwardly extending flange (57) with an axially inturned portion (58) having an outer portion (59) spaced radially inwardly from the outer generally cylindrical portion of the elastomeric member (16) but extending radially outwardly beyond the radially inner extremities of the retaining portions (38). During assembly, the wear sleeve flange's inturned portion (58) is snapped into the space between the retaining portions (38) and the case's radial flange (30).



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Unitized dual-lip shaft seal SPECIFICATION

This invention relates to an improved dual-lip grease-retaining and dirt-excluding shaft seal.

Background of the Invention

With customers demanding ever increasing quality and long life, automobile manufacturers have, in turn demanded more from the manufacturers of shaft seals. Some seals of the present invention are intended to be used on wheel spindles of automobiles, and to last without replacement for as long as 100,000 miles, while retaining the grease and excluding grit, dirt, corroding liquids, and so on. The seals heretofore made have not had so long a life. Moreover, the seal is required to be installable in a very small space.

Exclusion of deleterious foreign matter is even more important than the retention of the grease, as in certain applications grease may be added to the wheel bearings from time to time; in fact, it is desirable to have some grease flow out from the grease retaining seal lip into the space between the grease-retaining lip and the dirt-excluding lip, so as to lubricate both lips. It is not even harmful to have a small amount of grease expelled via the dirt-excluding lip during lubrication of the wheel bearings. However, the amount allowed to pass the grease-retaining lip should be kept very small.

In any event, there tends to be more wear at the dirt-excluding lip; because that lip is quite likely to come into contact with dirt, grit, dust and corroding liquids. It is also desirable to fling the outside foreign matter outwardly in such a way that it tends not to work its way to the dirt-excluding lip, but even with such

٦/ 1 flinging, there will still be a substantial amount of 2 deleterious foreign matter attempting to pass by the lip 3 over a period of driving an automobile 100,000 miles.

U.S. Patents Nos. 4,399,998 and 4,344,631 show some venting structure for seal lips, as does U.S. Patent 2,830,832, but none of these vents are suitable for use in the present seal.

It is also important that the seal be unitized, because with a precision product of this kind and of this size, wrong or careless installation can immediately ruin the sealing lips and lead to the manufacturer's having to make good his guarantee on the wheel bearings. Assembly-line workers in automobile plants are often careless, and even though they may try to be careful, separate installation of a seal and then of a dirt flinging member or of a wear sleeve to go upon the shaft tends to produce misalignments which considerably shorten the life of the seal, and may in fact cause its ruin within a few miles of the running of the new car.

There are many unitized seal structures, including those shown in U.S. Patents Nos. 3,021,161; 3,108,815; 3,179,424; 3,685,841; 3,561,770; 4,028,057; and 4,285,526, but few, if any, are applicable to a seal as narrow as that of the present invention. Some of the enumerated patents show dual-lip seals, but none like those of the present invention.

To insure long life at the dirt exclusion seal, a very long lasting seal composition is desirable. It is possible to make a seal having many of the features of the present invention by using only a standard high quality elastomer such as acrylic rubber, butyl rubber, or an ethylene acrylic rubber (e.g., Vamac[®], a DuPont[®] Reg. Trademark). However, the use of polytetrafluoroethylene, or an equivalent material, at the actual sealing edges is highly desirable. The incorporation of polytetrafluoroethylene becomes important due to the fact that the temperature of the seal during use may rise to between

1 300 and 350°F. Also the pressure from the grease side of 2 the seal may rise to the range of 50 to 60 p.s.i. at up to 3 about 1200 rpm, which corresponds to vehicle speeds of 80 4 to 90 miles per hour. Polytetrafluoroethylene also 5 reduces the torque of the seal on the wear sleeve.

Since polytetrafluoroethylene cannot be readily 7 and economically molded to complex shapes, it usually must 8 be incorporated into the seal by using a wafer-like 9 washer, as by bonding it to an elastomeric supporting 10 member. The present invention does this in novel manner 11 employing a novel method of manufacture to produce a 12 novel product. The method further, includes features in 13 addition to the incorporation of the polytetrafluoro-14 ethylene.

15 Polytetrafluoroethylene is shown bonded to elasto-16 mers in shaft seals in many patents, including U.S. 17 Patents Nos. 3,495,843 and 4,239,243 and East German 18 Patent No. 328,815, but, again the structure of the 19 present invention and the method of producing it do not 20 appear to be known.

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22 Summary of the Invention

23 The product of this invention is a unitized grease 24 seal and comprises a dual-lip seal member and a wear-25 sleeve member attached together, preferably releasably.

The seal member comprises a one-piece metal case, 27 a molded elastomeric member bonded to the metal case, and 28 a polytetrafluoroethylene lip member bonded to the elasto-29 meric member and providing the dirt-excluding sealing lip.

30 The case has a cylindrical outer portion defining 31 a wall with an outer surface adapted to be press fitted 32 into a stationary bore. If desired, part of the outer 33 surface may be covered with elastomer, and this elastomer 34 may be a portion of the elastomeric member. A reverse 35 cylindrical portion extends back from one end of the outer 36 wall and has an outer surface bearing against the inner 37 surface of that wall. The reverse portion is much shorter 22

1 than the outer portion, and from its inner end, a radial 2 flange extends inwardly to a radially inner end. The 3 flange has an outer face on the air side of the seal, 4 continuous with the inner face of the reverse portion.
5 The molded elastomeric member is bonded to the

The molded elastomeric member is bonded to the 6 metal case. Thus, a radially extending portion of the 7 elastomeric member is bonded to the outer face of the 8 radial flange, and an outer generally cylindrical portion 9 is bonded to the inner surface of the reverse portion. 10 This generally elastomeric cylindrical outer portion has a 11 series of radially inwardly extending wear-sleeve-12 retaining portions spaced circumferentially from each 13 other. An inner portion of the elastomeric member extends 14 inwardly of the radially inner end of the case's radial 15 flange, being bonded thereto, and has two diverging lip 16 portions, meeting, as molded, at about 90° at a point 17 spaced radially in from the inner end of the case, and 18 there is a cavity in between these lip portions. One of 19 these lip portions is on the grease side of the seal, and 20 it has a grease-retention lip provided with a series of 21 spaced-apart small relieved indentations enabling passage 22 of small amounts of grease into the cavity. The other lip 23 portion provides a dirt-excluding lip portion. Preferably, 24 it has a cylindrically extending recess therein, and a 25 polytetrafluoroethylene sealing lip member fits into the 26 recess and is bonded to the elastomeric member. This poly-27 tetrafluoroethylene lip preferably provides the sealing 28 edge portion of that lip portion.

In addition to the seal member, there is a onejece metal wear sleeve and deflector member having a
radially inner, cylindrical, wear sleeve portion with an
inner surface adapted to be press fitted on a rotatable
shaft and an outer surface engaged by both of the sealing
lips. The outer diameter of this cylindrical portion is
greater than that of the as-made inner diameter of the
sealing lips, so that assembly of the wear sleeve on the
member causes further spreading-apart of the two

1 lips. The dirt-excluding lip, when in position on the wear 2 sleeve, has an end wall on its air side that is substan-3 tially perpendicular to the wear sleeve's outer surface, 4 or as nearly perpendicular as is practical.

The wear sleeve member also has a unitizing 6 radially outwardly extending flange portion serving as a 7 deflector and slinger to protect the dirt-excluding lip 8 from much of the foreign matter that otherwise come into 9 contact with that lip. It also helps to unitize the 10 assembly. Preferably it first extends radially outwardly 11 from the air-side end of the wear sleeve's cylindrical 12 portion and then turns in toward the radial flange of the 13 case. Near or at its outer end, a portion is spaced 14 inwardly from the outer, generally cylindrical portion of 15 the elastomeric member but extends outwardly beyond the 16 radially inner extremities of the elastomeric retaining 17 portions, so that this deflector portion of the wear 18 sleeve member can be snapped into the space between the 19 elastomeric retaining portions and the elastomer-coated 20 radial flange of the metal case.

The invention also includes a method for making the unitized dual-lip shaft seal.

It may begin by seating on a first mold member the 23 24 one-piece metal case, its outer bore-engaging cylindrical 25 portion being seated against a second mold member, appro-26 priate parts of the case being covered with elastomer-27 bonding cement. A third mold member is engaged with the 28 first mold member so as to define between them a cavity 29 for molding to finished size and shape the grease-facing 30 lip, at an angle of about 450 to the radial flange. The 31 third mold member is also shaped to provide a series of 32 projections in the cavity that provide the spaced-apart 33 indentations in the grease-retaining lip. This third mold 34 member also provides one surface of the cavity for the 35 dirt-excluding lip, this surface sloping in the opposite 36 direction from the grease-lip cavity, at an angle of 37 about 450 to the radial flange, so that the two cavities 1 meet at about 90°. The sloping surface leads to a ledge 2 spaced away from the radial flange and parallel to the 3 plane thereof; the ledge ends at an inner cylindrical 4 boundary.

A flat washer of polytetrafluoroethylene is placed on the ledge with the inner circumference of the washer engaging the boundary and the outer circumference extending beyond the ledge and overhanging a portion only of the sloping surface. Appropriate surface portions of the washer are treated beforehand, as by acid etching and then with bonding cement, to enhance the bonding of elastomer thereto.

13 A ring of uncured elastomer ("prep") is placed on 14 top of the portion of the polytetrafluoroethylene washer 15 supported by the ledge, and a fourth mold member is 16 brought toward and against the second and third mold 17 members to close the mold, all of the mold members being 18 heated to a molding and curing temperature. Closing the 19 mold defines the remainder of the mold cavity for the 20 dirt-excluding lip and defines a further cavity for the 21 radial portion next to said radial flange and the outer 22 cylindrical portion of the elastomeric member. This outer 23 cylindrical portion of the mold is shaped to provide a set 24 of circumferentially spaced apart cavity portions extend-25 ing radially inwardly to provide the wear-sleeve retention 26 members. The movement of the fourth mold member simulta-27 neously forces the elastomer to flow into all the mold 28 cavities and also to flex the overhanging portion of the 29 polytetrafluoroethylene washer into engagement with the 30 sloping mold surface and to initiate bonding of the 31 elastomer to the case and to the washer.

The elastomer is then cured under heat and pressure to a desired cure, so that it holds its shape and completes the bonding of the elastomer to the case and the washer. Thereby, it produces the shaft sealing member, which has a grease-retaining lip molded to its final shape and a dirt-excluding lip, which at that time has a portion

1 extending generally inwardly therefrom; the shaft sealing 2 member also has its molded set of wear-sleeve retention 3 members spaced away from the case's radial flange. The 4 mold is then opened and the shaft sealing member removed.

Next, the dirt-excluding lip is trimmed to a 6 desired length, the edge being trimmed at a desired angle 7 so that when the seal is unitized and the lips are spread 8 apart, the trimmed edge is nearly parallel to the case's 9 radial flange.

In addition, a one-piece metal wear sleeve is 11 formed with a cylindrical portion for engagement with both 12 sealing lips and of a diameter to spread apart those lips 13 and, as a result, to move the trimmed edge to its afore-14 mentioned nearly-parallel position. The wear sleeve also 15 has a shaped radially outwardly extending deflecting 16 portion, of a size enabling unitization.

Then, the wear sleeve and shaft sealing member are assembled together. The sleeve's radially outwardly extending portion is placed on the air side of the shaft sealing member, and the lips are placed in engagement with the cylindrical portion of the wear sleeve. The radially outwardly extending portion is then snapped into the space between the elastomeric retention members and the elastomer-covered radial flange, so that the retention members thereafter hinder retraction of the wear sleeve from the shaft-sealing member, although it can, if desired, be taken off.

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29 Brief Description of the Drawings

Fig. 1 is a view in end elevation of a unitized 31 dual-lip shaft seal embodying the principles of the 32 invention.

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34 Fig. 2 is a greatly enlarged view in section of 35 one portion of the seal taken along the line 2-2 in 36 Fig. 1.

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Fig. 3 is a further enlarged view in cross section 2 of the shaft seal element alone shown in its as-molded and 3 trimmed position. 5 Fig. 4 is a similarly enlarged view of the wear 6 sleeve. Fig. 5 is a view similar to Fig. 2 of a modified 9 form of the invention employing a differently shaped wear 10 sleeve and a modified form of the outer portion of the 11 outer seal of Fig. 2. 12 13 Fig. 6 is a view in section of approximately half 14 of the lower parts of a mold for molding the shaft seal, 15 shown with the mold open and the case, the polytetra-16 fluoroethylene washer, and the raw elastomer placed in 17 position. 18 19 Fig. 7 is a similar view of the mold in its closed 20 position. 21 22 Fig. 8 is a fragmentary enlarged view in section 23 of a portion of Fig. 7, showing the seal as molded and 24 indicating the trim line. 25 26 Description of a Preferred Embodiment 27 As shown in Fig. 1 a unitized seal 10 of the 28 invention is a continuous annular device. As shown in 29 Figs. 1 and 2, the seal 10 comprises a sealing member 11, 30 and a wear sleeve member 12, which are assembled together 31 in a manner resulting in unitization, so that the seal is 32 installed as a unitized assembly 10, rather than having 33 separate installation of its two major components 11 and 34 12.

36 comprises three major elements which are best seen in Fig. 37 3, which presents the as-molded and trimmed sealing member

elastomeric seal member 11 preferably

1 ll. This member 11 comprises a metal case member 15, an 2 elastomeric member 16 which is bonded to the case 15, and 3 a polytetrafluoroethylene insert 17 which is bonded to the 4 elastomeric member 16.

The case 15 is a unitary annular metal member 6 shaped to provide a cylindrical outer portion 20 having 7 an outer surface 21 for leak-tight engagement in the bore 8 of a housing. The outer surface 21 is preferably coated g with a suitable bore-locking material, not shown. One end 10 22 of the portion 20 is free and the other end 23 is 11 curved back on itself to provide a short inner cylindrical 12 portion 24 with its outer surface 25 bearing against the 13 inner periphery 26 of the portion 20. The portion 24 has 14 an inner surface 27, and it is curved inwardly at its end 15 28 to provide a radial flange 30 having an outer or air-16 side surface 31, an inner or grease-side surface 32, and 17 a radially inner end 33. To this end 33 and to the inner 18 portions of the surfaces 31 and 32 is bonded the elasto-19 meric sealing element 16. The actual molding will be 20 described later, in conjunction with Figs. 6 and 7.

The elastomeric sealing element 16 may be of any suitable elastomer; it is a unitary member having a radially extending portion 35 bonded to the surface 31 of the radial flange 30, and an outer cylindrical portion 36 bonded to the surface 27 of the case 15. This cylindrical portion 36 is provided near its axial end 37 with a series, usually four, of inwardly directed projections 38 which provide short retaining members for holding the wear sleeve member 12 in its unitized position.

The radially inner portion of the elastomeric member 16 comprises two lip portions 40 and 41. The lip portion 40 comprises an as-molded lip edge 42 which need not be trimmed and which faces at an angle of about 45° away from the radial flange 30 of the case 15. It serves as the grease-retaining lip 40. Its lip edge 42 may have a slight curvature and is preferably provided with a series, preferably three, of short lip vents 43, which

1 are equally spaced around the periphery, and may be, and 2 preferably are, approximately 0.005° deep by 0.125° wide. 3 The purpose of these vents 43 is to permit the entry of 4 grease from the bearing chamber into a cavity 44 in 5 between the two lips to keep the lips lubricated. The 6 amount of grease desired there is relatively small, and 7 therefore the vent passages 43 are quite small, so that 8 they do not significantly interfere with grease 9 retention.

The other sealing lip portion 41 is made consider-10 11 ably wider than the lip portion 40 to provide a good 12 support for the polytetrafluoroethylene insert 17, which 13 takes up approximately half the width of the lip portion 14 41 and which must be bonded to and securely retained by 15 the elastomeric lip portion 41. Thus, the elastomer itself 16 may be considered as having converging walls 45 and 46 and 17 a recess having walls 47 and 48. Into the recess and flush 18 with the walls 47 and 48 is the polytetrafluoroethylene 19 member 17. The lip portion 41 and the tetrafluoroethylene 20 member 17 have a common trimmed edge 50 which is not 21 perpendicular to the wall 45 but is, instead, so trimmed 22 that when the sealing member 11 is assembled on the wear 23 sleeve member 12, the trimmed edge 50 will approach as 24 closely as possible a right angle to the wear sleeve, as 25 can be seen in Fig. 2. The limiting factor here is what 26 the shape and dimensions of the seal enable the trimming 27 knife to do without cutting any of the other parts. 28 Typically this means that trim lies at an angle of about 29 30° to a plane parallel to the radial flange 30. The way 30 in which the seal is made will be described later. In any 31 event, the trimming results in an originally sharp sealing 32 lip edge 51, what becomes blunted as the lip wears.

33 The wear sleeve member 12 is a formed metal 34 member, preferably made from the kind of sheet steel 35 usually used for this type of installation, typically 36 treated with phosphoric acid or some similar solution. 37 This member 12, as shown in Fig. 4, has a wear sleeve 52

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1 proper, the inner periphery 53 of which fits snugly on a 2 shaft, while its outer periphery 54 serves as the surface 3 upon which the seal lips 42 and 51 run, as can be seen in 4 Fig. 2. One end 55 facing the bearing is a free end, while 5 at the other end 56 the wear sleeve member 12 is curved 6 outwardly to provide a radially extending portion 57 7 followed by an angularly extending portion 58 that goes 8 back in axially, toward the opposite end 55, terminating 9 at an end 59. The ends 55 and 59 are cut off before the 10 forming. The angular portion 58 is shown extending at an 11 angle of about 450 to the radial portion 57, and the end 12 59 lies out beyond the projections 38 but spaced out from 13 the inner surface of the cylindrical portion 36. Thus, the 14 outer periphery 59 can be snapped into the four or more 15 protuberances or retaining members 38 to unitize the seal 16 10. The spacing apart of the members 38 and the flexi-17 bility of the elastomer make assembly a very simple 18 matter.

When the members 11 and 12 are assembled to complete the seal 10 (Fig. 2) the two lips 42 and 51 are spread apart more widely than before (Fig. 3), and the cavity 44 between them is somewhat reduced in height, but is spread in width. The recesses 43 for admitting grease into the cavity 44 are operative, and the polytetrafluoro-ethylene sealing member 17 has its axially outer edge 50 substantially parallel to the radial portion 57 of the wear sleeve member 12, as well as to the radial flange 30 of the seal case 15.

The portions 57 and 58 of the wear sleeve member 30 12 act as a deflector and as a slinger, to free the seal 31 as much as possible from water and corrosive liquids, as 32 well as from dirt and dust.

To obtain somewhat better operation of this 34 slinging-deflecting feature, the wear sleeve structure 60 35 shown in Fig. 5 may be used, although it is more difficult 36 to form and therefore somewhat more expensive. In this 37 instance, after a short radial portion 61 at the end of 1 the wear sleeve proper 62, the metal has a portion 63
2 bent inwardly axially toward the opposite end of the wear
3 sleeve 62, at approximately 90° and then has a bent-out
4 portion 64 lying parallel to the radial flange 30, when
5 installed, and then a final portion 65 is bent back at an
6 acute angle to bring its end 66 out within the inner
7 diameter of the retention members 38. This bending back
8 results in leaving axially inside the members 38 the part
9 of the portion 65 which is of greater diameter than the
10 retaining members 38, though of lesser diameter than the
11 cylindrical surface 36 from which the retaining members 38
12 project. This structure provides an improved slinging
13 action, while taking up no more room. However, its practi14 cality depends partly on the necessity for any greater
15 slinging action, and on the additional costs involved.

As would probably be apparent anyway, the exterior part of the case 15 may be at least partially coated with 18 elastomer, as is also shown in Fig. 5. Here, an outer 19 portion 70 of the elastomer is formed to cover the 20 exterior surface 71 of an inwardly stepped portion 72 of 21 the case. The rubber coating 70, since it is able to 22 accommodate itself to the bore diameter by some flow 23 towards its end, is made a little larger in diameter than 24 the remaining portion 73 of the bore-engaging portion of 25 the metal case.

Going now to the method of manufacture of the seal, a preferred such method incorporates a four-piece mold 75 as shown in Figs. 6 and 7. The mold 75 is shown in a particular orientation which will be used for description, although a different orientation is possible. A stationary mold base 80 is shaped to provide a bottom planar surface 81 with an inner cylindrical surface 82 and an outer cylindrical surface 83. The inner cylindrical surface 84, which, in turn, leads out to a short cylindrical surface 85, and then to an inclined frustoconical portion 86. At the outer end of the portion 86 is a shelf 87

1 connected by a step 88 to a short case-engaging planar 2 rest 89. From there, a radius portion 90 leads to a 3 cylindrical portion 91 terminating at a planar shoulder 4 92. The outer edge of the shoulder 92 terminates at a 5 frustoconical outer surface 93, at the lower end of which 6 is a flash trap 94 followed by a planar shelf 95 leading 7 to the outer cylindrical surface 83.

A second, outer, mold member 100 is placed partly g around and partly upon the base mold member 80. It has an outer generally cylindrical surface 101 and a lower flat annular face 102 which engages the annular shelf 95. It also has a frustoconical surface 103 bearing against the frustoconical surface 93 of the first mold member 80. Above that is a short cylindrical portion 104 going up to another frustoconical surface 105 that leads to an upper planar face 106 extends out to its outer surface 101.

The metal case 15 is preferably placed with its outer surface 21 bearing against the cylindrical portion 19 104 of the mold member 100 and with the surface 32 of its radial flange 30 resting upon the rest 89, while most of the inside surface 26 the case portion 15 is spaced away 22 from the cylindrical portion 91.

A third, inner, mold member 110 has a stepped 23 24 generally cylindrical inner through opening with a lower 25 cylindrical surface 111, a step 112, and an upper cylin-26 drical surface 113. A mold pin 114 has a head 115 engaging 27 the step 112 and forcing a lower annular face 116 of the 28 mold member 110 snugly against the annular surface 84. A 29 cylindrical face 117 engages the cylindrical surface 85, 30 and a frustoconical surface 118 engages and overlies the 31 frustoconical surface 86 of the first mold member 80. 32 However, the upper and outer end of the surface 118 is 33 shaped to provide a cavity 120 between the two mold 34 members 80 and 110 adjacent to the shelf 87. The cavity 35 120 provides the as-molded grease-retaining lip portion 36 40. At its upper end, the cavity 120 is terminated, and a 37 frustoconical portion 121 leads upwardly to an inwardly

1 extending ledge 122. The ledge 122 then leads to a nearly 2 cylindrical tapered portion 123 ending in an annular 3 planar portion 124 which leads in to the inner periphery 4 113.

A polytetrafluoroethylene washer 125, which 6 preferably has been acid etched on one surface provided 7 and then with a coating of bonding cement there and on its 8 outer periphery 126, is placed on top of the ledge 122, 9 with the etched and coated surface facing up and with its 10 inner periphery 127 abutting the tapered portion 123. The 11 washer 125 extends out beyond the ledge 122 and overhangs 12 a portion of the frustoconical surface 121. Atop the 13 washer 125 is placed a ring 128 of uncured elastomer 14 calculated to provide the proper amount for filling the 15 molded cavities provided for the elastomer.

A fourth or upper mold member 130 is attached to 17 an upper mold pin 131 having a head 132 that partially 18 compresses a series of springs I33 against a lower 19 shoulder 134 of the member 130. Like the first mold member 20 80, the member 130 has a flash receiving cavity 135 at the 21 outer end of a planar lower face portion 136 and at the 22 inner end of a tapered portion 137 that mates with the 23 tapered portion 123 of the third mold member 110 when the 24 mold 75 is in its closed position. At the lower end of the 25 tapered portion 137 is a planar annular surface 138 26 leading to a frustoconical portion 140, the surfaces 138 27 and 140 defining part of the mold cavity for the dirt-28 excluding lip 41. The surface 140 is succeeded by a short 29 radial portion 141 followed by a cylindrical step 142 30 leading to a short annular planar surface 143, from the 31 outer end of which a tapered portion 144 leads outwardly 32 and upwardly. The tapered portion 144 mates with the 33 tapered portion 105 of the second mold member 100 and has 34 another flash-receiving cavity 145 at its outer end. 35 Beyond that is a planar surface 146 that mates with the 36 surface 106 of the second mold member 100 and leads to an 37 outer cylindrical surface 147.

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When the heated mold is closed during the progress 1 2 from the position shown in Fig. 6 to that of Fig. 7, the 3 mold cavities are defined, and simultaneously the elasto-4 mer is caused to flow thereinto. If there is any excess 5 elastomer it flows into the flash-receiving cavities 135 6 and 145. This flash is relatively easily removed from the 7 molded seal. However, no flash forms on the as-molded lip 8 40. During this operation the elastomer and the fourth or 9 upper mold member 130 act upon the polytetrafluoro-10 ethylene washer 125 to force its overhanging portion flush 11 against the frustoconical surface 121 while bonding the 12 elastomer to it. After the mold 75 is closed, it is held 13 closed until cure of the elastomer has been completed, and 14 then it is parted and the sealing member is ejected by 15 conventional means.

As will be seen from the mold drawing, the inner 17 portion of the polytetrafluoroethylene washer 125 and the 18 elastomer there must be trimmed off. The trimming is along 19 the line 150 in Fig. 8, leaving the edge 50 shown in Fig. 20 3, so that the inner periphery of the lip edge 52 is 21 smaller in diameter than that of the the grease-retaining 22 lip edge 51, the trimming being made, as stated before, 23 at an angle of about 30° to the plane of the radial flange 24 30 and, in any event, such that the surface 50 will become 25 nearly a right angle when the seal is unitized.

The wear sleeve member 12 is made by conventional 26 27 forming means to the desired shape, and is, as already 28 been said, snapped into the oil seal member 11, so that 29 the retaining members 38 thereafter hold it in place. The 30 seal assembly 10 can, if actually need be, taken apart, 31 but this is far from normal, and it is almost always left 32 together. It will not come apart accidentally because of 33 the retention members 38.

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To those skilled in the art to which this inven-35 36 tion relates, many changes in construction and widely 37 differing embodiments and applications of the invention

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1 will suggest themselves without departing from the spirit
 2 and scope of the invention. The disclosures and the
 3 descriptions herein are purely illustrative and are not
 4 intended to be in any sense limiting.
           What is claimed is:
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A unitized grease seal, including
          1.
 2 combination:
           a seal member having
 3
           a one-piece metal case having a cylindrical bore-
 4
 5 sealing portion with an inner surface and an inwardly
 6 extending radial flange, in between the ends of said bore-
 7 sealing portion, having a radially inner end, an air-side
 8 radial surface, and an opposite grease-side radial
 9 surface,
          a molded elastomeric member bonded to said metal
10
11 case and having a radially extending portion bonded to
12 said air-side radial surface, an outer generally cylin-
13 drical portion bonded to said inner surface of the bore-
14 sealing portion on the air side of said flange
15 providing a series of radially inwardly extending retain-
16 ing portions spaced circumferentially from each other,
17 and
          said elastomeric member also having an inner
18
19 portion extending radially inwardly of said inner end of
20 said radial flange and having two diverging lip portions
21 with a cavity between them, one said lip portion providing
    a grease retention lip having small spaced-apart shallow
23 indentations enabling passage of small amounts of grease
24 into said cavity, the other said lip portion having a
25 polytetrafluoroethylene insert bonded to said elastomeric
26 member and providing the sealing edge portion of a dirt-
27 excluding lip, and
          a one-piece metal wear sleeve member having a
28
29 radially inner shaft-engaging cylindrical portion having
30 an outer surface engaged by said lips and having a larger
31 outer diameter than the free-standing inner diameter of
32 said lips, so that assembly of the wear sleeve on the seal
33 member causes further spreading-apart of said two lips,
34 said dirt-excluding lip when in position on said wear
35 sleeve having an end wall on its air side that is sub-
36 stantially perpendicular to said wear sleeve's outer
37 surface,
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said wear sleeve member also having a radially outwardly extending flange on its air-side end, with an axially inturned portion having an outer portion spaced radially inwardly from the outer generally cylindrical portion of said elastomeric member but extending radially outwardly beyond the radially inner extremities of said retaining portions, so that during assembly, the wear sleeve flange's inturned portion can be snapped into the axially extending space between said retaining portions and the elastomer-covered radial flange.

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2. The grease seal of claim 1 wherein said wear sleeve's flange has a truly radial portion where it meets said cylindrical wear sleeve portion, extending beyond said end wall of said dirt-excluding lip followed by an angularly extending portion, going toward said case's radial flange and ending at its radially outermost, axially innermost point.

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3. The grease seal of claim 1 wherein said wear sleeve's flange has a truly radial portion where it meets the wear sleeve's cylindrical portion, extending beyond said dirt-excluding, lip followed by an axially inwardly extending portion going toward said case's radial flange, followed by a radially extending portion parallel to said case's radial flange and extending out radially beyond said retaining portions, followed by an axially outwardly and radially inwardly extending angular portion ending substantially flush axially with the end of said boresealing portion and radially within said retainer portions.

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4. A unitized dual-lip grease seal, including in
 1
 2 combination:
          a seal member having
          a one-piece metal case with a cylindrical bore-
 4
 5 sealing portion having an inner surface and an inwardly
 6 extending radial flange, in between the ends of said bore-
7 sealing portion, having a radially inner end, an air-side
 8 radial surface and an opposite grease-side radial
9 surface,
           a molded elastomeric member bonded to said metal
10
11 case and having a radially extending portion bonded to and
12 completely covering said air-side radial surface, an
13 outer generally cylindrical portion bonded to and covering
14 that portion of said inner surface of the bore sealing
15 portion which lies on the air side of said flange and
16 providing a series of radially inwardly extending retain-
17 ing portions spaced circumferentially from each other,
           said elastomeric member also having an inner
18
19 portion extending radially inwardly of said inner end and
20 bonded thereto and having two diverging lip portions,
21 meeting, as molded, at about 90° at a point spaced
22 radially in from said inner end and with a cavity between
23 them, one said lip portion providing a grease retention
24 lip and the other dirt-excluding lip, and
           a one-piece metal wear sleeve member having a
26 radially inner shaft-engaging cylindrical portion having
27 an outer surface engaged by said lips and having a larger
28 outer diameter than the free-standing inner diameter of
29 said lips, so that assembly of the wear sleeve on the seal
30 member causes further spreading-apart of said two lips,
31 said dirt-excluding lip when in position on said wear
32 sleeve having an end wall on its air side that is sub-
33 stantially perpendicular to said wear sleeve's outer
34 surface,
           said wear sleeve member also having a radially
36 outwardly extending flange on its air side end, with an
37 axially inturned portion having a radially outermost
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1 portion spaced inwardly from the outer generally cylin-2 drical portion of said elastomeric member but extending 3 radially outwardly beyond the radially inner extremities 4 of said retaining portions, so that, during assembly, the 5 wear sleeve flange's inturned portion can be snapped into 6 the space between said retaining portions and the 7 elastomer-covered radial flange.

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9 5. The grease seal of claim 4 wherein said grease-10 retaining lip is provided with spaced-apart shallow 11 indentations.

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6. The grease seal of claim 4 wherein said dirtexcluding lip has a polytetrafluoroethylene insert bonded thereto and providing the sealing edge.

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7. A unitized grease seal, including in 18 combination:

19 a seal member having

a one-piece metal case with a cylindrical outer portion defining a wall with an outer surface adapted to be press-fitted into a stationary bore and an inner surface, a reverse cylindrical portion extending back from one end of said wall and having an outer surface bearing against said inner wall surface and an inner surface, said reverse portion being much shorter than said outer portion, and an inwardly extending radial flange leading from the axially inner end of said reverse portion and having a radially inner end, an outer face on the air side of said seal and continuous with the inner face of said reverse portion, and an opposite inner face on the grease side of said seal,

a molded elastomeric member bonded to said metal case and having a radially extending portion bonded to and covering said outer face of said radial flange, an outer generally cylindrical portion bonded to and covering the

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1 inner surface of said reverse portion and providing a 2 series of radially inwardly extending retaining portions 3 spaced circumferentially from each other,

said elastomeric member also having an inner portion extending radially inwardly of said radially inner end of said radial flange and bonded thereto and having two diverging lip portions, meeting, as molded, at about 90° at a point spaced radially in from said inner end and with a cavity between them, one said lip portion being on the grease side of the seal and having a grease-retention lip provided with a series of spaced-apart shallow indentations enabling passage of small amounts of grease into said cavity, the other said lip portion providing a dirt-excluding lip portion having a cylindrically extending recess therein, and

a polytetrafluoroethylene sealing lip member fitting in said recess and bonded to said elastomeric member and providing the sealing edge portion of said dirt excluding lip, said lip having an end wall on its air side,

a one-piece metal wear sleeve member having a radially inner cylindrical portion with an inner surface adapted to be press fitted on a rotatable shaft and an outer surface engaged by both said lips and having a larger outer diameter than the inner diameter of said lips before assembly with said wear sleeve member, so that assembly of the wear sleeve on the seal member causes further spreading-apart of said two lips, the end wall of said dirt-excluding lip, when said lip is in position on said wear sleeve being substantially perpendicular to said wear sleeve's outer surface,

said wear sleeve member also having a flange gradient portion extending radially outwardly from the air side end the wear sleeve's cylindrical portion and an inturned portion at an angle to said radial flange and extending axially toward said case's radial flange and having an outer end spaced radially inwardly from the outer gener-

ally cylindrical portion of said elastomeric member but extending radially outwardly beyond the radially inner extremities of said retaining portions, so that the inturned portion of said wear sleeve member can be snapped into the space between said retaining portions and said radial flange of said metal case.

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8. The grease seal of claim 7 wherein said wear 9 sleeve's flange has a truly radial portion where it meets 10 said cylindrical wear sleeve portion, extending beyond 11 said end wall of said dirt-excluding lip followed by an 12 angularly extending portion, going toward said case's 13 radial flange and ending at its radially outermost, 14 axially innermost point.

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9. The grease seal of claim 7 wherein said wear sleeve's flange has a truly radial portion where it meets the wear sleeve's cylindrical portion, extending beyond said dirt-excluding lip, followed by an axially inwardly extending portion going toward said case's radial flange, followed by a radially extending portion parallel to said case's radial flange and extending out radially beyond said retaining portions, followed by an axially outwardly and radially inwardly extending angular portion ending substantially flush axially with the end of said boresealing portion and radially within said retainer portions.

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29 10. The grease seal of claim 7 wherein said 30 cylindrical outer portion is stepped and said elastomeric 31 member has a portion extending from said outer generally 32 cylindrical portion to the outer surface of said wall and 33 bonded thereto to provide a bore-engaging outer 34 periphery.

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including

seal

member,

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11.
                    grease
 2 combination:
           a one-piece metal case with a cylindrical bore-
 4 sealing portion and an inwardly extending radial flange
 5 having a radially inner end,
           a molded elastomeric member bonded to said metal
 7 case and having an inner portion extending radially
 8 inwardly of said radial flange and having two diverging
 9 lip portions, meeting, as molded, at about 90^{\circ} at a point
10 in line with said flange and with a cavity between them,
11 one said lip portion providing a grease-retention lip
12 having spaced-apart small relieved indentations enabling
13 passage of small amounts of grease into said cavity, the
14 other said lip portion having a polytetrafluoroethylene
15 insert bonded to said elastomeric member and providing the
16 sealing edge portion of a dirt-excluding lip.
17
           12. The sealing member of claim 11 wherein said
18
19 dirt excluding lip has an air-side end wall, which upon
20 installation of said sealing member on a contacting
21 surface for sealing therewith, with further spreading-
22 apart of said two lips, becomes substantially perpendicu-
23 lar to said contacting surface.
24
           13. A method for making a unitized dual-lip shaft
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26 seal for sealing in grease and sealing out dirt and other
27 foreign matter, with one lip having a polytetrafluoro-
28 ethylene insert sealing member, comprising:
           seating on a first mold member a one-piece metal
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30 case, while seating the case's outer bore-engaging cylin-
31 drical portion against a second mold member, the case
32 having an axially inset radial flange with an air-facing
33 side and a grease-facing side, appropriate parts of said
34 case being covered with elastomer-bonding cement,
           engaging a third mold member with said first mold
36 member so as to define between them a cavity for molding
37 to finished size and shape a grease-facing lip at an
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1 angle of about 450 to said radial flange, and also provid-2 ing one surface of another cavity for an air-facing lip, 3 sloping in the opposite direction at an angle of about 45° 4 to said radial flange, so that the two cavities meet at 5 about 90° to each other, said surface leading to a ledge 6 spaced away from said radial flange and parallel to the 7 plane thereof, said ledge ending at an inner cylindrical 8 boundary,

9 placing a flat washer of polytetrafluoroethylene 10 on said ledge with an inner circumference of said washer 11 engaging said boundary and an outer circumference extend-12 ing beyond said ledge and overhanging a portion only of 13 said sloping surface, with appropriate surface portions of 14 said washer being treated to enhance bonding of elastomer 15 thereto,

16 positioning a ring of uncured elastomer on top of 17 the portion of said washer supported by said ledge,

bringing a fourth mold member toward and against 19 said second and third mold members, while all said mold 20 members are heated to a molding and curing temperature, so 21 as to define the remainder of the mold cavity for the 22 air-facing lip and to define a further cavity having a 23 radial portion next to said radial flange and an outer 24 cylindrical portion next to the cylindrical portion of 25 said case and shaped to provide a set of circumferentially 26 spaced-apart cavity portions extending radially inwardly 27 to provide retention members, all while forcing said 28 elastomer to flow into all the mold cavities and also to 29 flex the overhanging portion of said washer into engage-30 ment with said sloping surface and to initiate bonding of 31 the elastomer to said case and said washer,

curing said elastomer to a desired amount so that 33 it holds its shape and completes the bonding to said case 34 and said washer, to produce a shaft sealing member with a 35 grease-facing lip molded to its final shape and an air-

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16 unitization,

1 facing lip having a portion extending generally inwardly
2 therefrom, said shaft sealing member also having a set of
3 retention members spaced away from said radial flange,
4 then opening said mold and removing said shaft
5 sealing member,
6 trimming said air-facing lip to a desired length
7 at a trimmed edge having a desired angle so that, when the
8 product is unitized, the trimmed edge is nearly parallel
9 to said radial flange,
10 forming a one-piece metal wear sleeve having a
11 cylindrical portion for engagement with both said lips and
12 of a size to force spreading apart of those lips and, as a
13 result, moving the trimmed edge to its said nearly14 parallel position, said wear sleeve also having a radially

assembling said wear sleeve and shaft sealing 18 member together, with the sleeve's radially outwardly 19 extending portion on the grease side of said shaft sealing 20 member, the lips being in engagement with the cylindrical 21 portion of said wear sleeve, and

15 outwardly extending portion of a size enabling

snapping the radially outwardly extending portion into the space between said retention members and said elastomer-covered radial flange, said retention members thereafter hindering retraction of the wear sleeve from said shaft-sealing member.

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14. A method for making a dual-lip shaft seal for sealing in grease and sealing out dirt and other foreign matter, with one lip having a polytetrafluoroethylene insert sealing member, comprising:

seating on a first mold member a one-piece metal case, while seating the case's outer bore-engaging cylindrical portion against a second mold member, the case having a radial flange with an air-facing side and a grease-facing side, appropriate parts of said case being covered with elastomer-bonding cement,

engaging a third mold member with said first mold member so as to define between them a cavity for molding to finished size and shape a grease-facing lip at an angle of about 45° to said radial flange, and also providing one surface of another cavity for an air-facing lip, sloping in the opposite direction at an angle of about 45° to said radial flange, so that the two cavities meet at about 90° to each other said surface leading to a ledge spaced away from said radial flange and parallel to the plane thereof, said ledge ending at an inner cylindrical boundary,

placing a flat washer of polytetrafluoroethylene
on said ledge with an inner circumference of said washer
engaging said boundary and an outer circumference extending beyond said ledge and overhanging a portion only of
said sloping surface, with appropriate surface portions of
said washer being treated to enhance bonding of elastomer
thereto,

positioning a ring of uncured elastomer on top of the portion of said washer supported by said ledge,

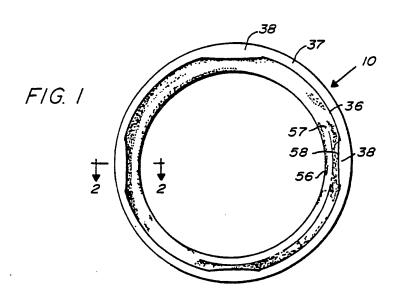
bringing a fourth mold member toward and against said second and third mold member, while all said mold members are heated to a molding and curing temperature, so as to define the remainder of the mold cavity for the air-facing lip, all while forcing said elastomer to flow into all the mold cavities and also to flex the overhanging portion of said washer into engagement with said sloping surface and to initiate bonding of the elastomer to said case and said washer,

curing said elastomer to a desired amount so that it holds its shape and completes the bonding to said case and said washer, to produce a shaft sealing member with a grease-facing lip molded to its final shape and an air facing lip having a portion extending generally inwardly therefrom,

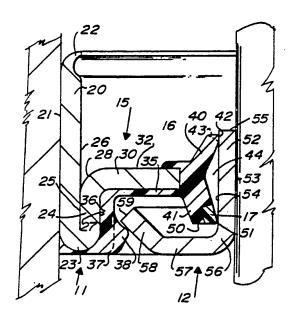
36 then opening said mold and removing said shaft 37 sealing member, and

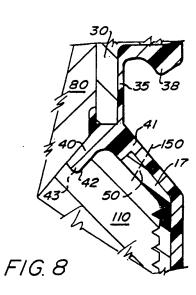
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trimming said air-facing lip to a desired length.
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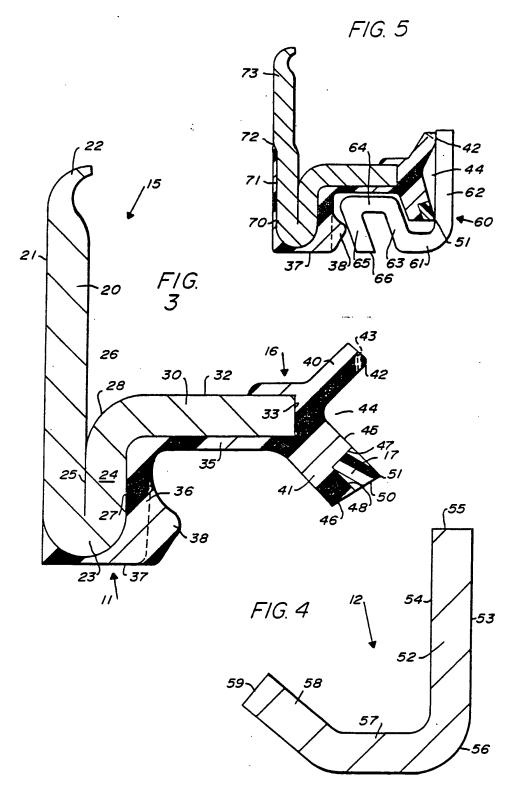


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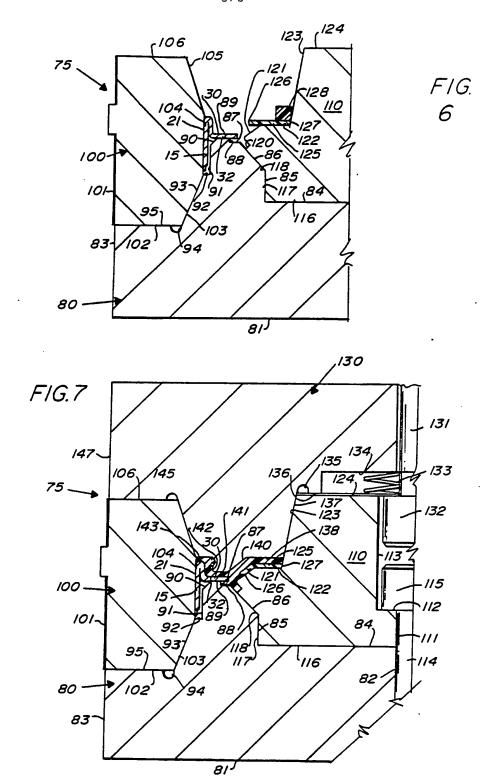




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SUBSTITUTE SHEET



INTERNATIONAL SEARCH REPORT

International Application No PCT/US 85/00188

I. CLAS	SIFICATION OF	SUBJECT MATTER (it several cit	essification symbols apply, indicate all) *	
Accordin	ng to International i	Patent Classification (IPC) or to both	National Classification and IPC	
IPC ⁴ :	F 16 J	15/32	_	
II. FIELD	S SEARCHED			
Classificati	ing Survey	Minimum Docu	mentation Searched 7	
	tion System		Classification Symbols	
IPC ⁴		F 16 J	•	
			er than Minimum Documentation nts are included in the Fields Searched *	
		DERED TO BE RELEVANT		7
Category •	Citation of L	Jocument, 11 with Indication, where a	ppropriate, of the relevant passages 12	Relevant to Claim No. 13
Y	FR,	A, 2430555 (IAO) see page 1, line line 30; claim 1	37 - page 2,	1,2,4,8
Y	FR,	A, 2296800 (GOET 1976 see page 3, line 15; figures 1,3,	29 - page 4, line	1,4
A	EP,	A, 0065887 (SOC. ROULEMENTS) 1 Dec see claim 1; fign	cember 1982	1,2,4,8
A .	FR,	A, 2373003 (GARLO see page 2, line 36; figures 1-3 application)	18 - page J, line	1,6,11,13,14
A	FR,	A, 1508575 (CHRON see page 2, left- paragraph 8 - ric paragraph 11; fig	ght-hand column,	1,6,11,13,14
Special categories of cited documents: 10 "A" document defining the general state of the art which is not considered to be of particular relevance "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the				
"L" docur	ment which may the	blished on or after the international row doubts on priority claim(s) or sh the publication date of another	"X" document of particular relevance cannot be considered novel or involve an inventive step	s; the claimed invention cannot be considered to
citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date but exhibition or other means.				
	the the profity ca	te claimed	"&" document member of the same pa	tent family
IV. CERTIFICATION Date of the Actual Completion of the International Search Date of Mailing of this International Search				
	May 1985		Date of Mailing of this international Section 1 0 JUIN 1985	ch Resort
International Searching Authority Signature of Authorized Officer				
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m PCT//SA/210 (second short) // G.L.M. Kruydenberg/				

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)					
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No			
A	FR, A, 2238875 (SIMMERWERKE) 21 Febru- ary 1975	1 6 11 12			
A	see page 2, lines 19-36; figure 1 US, A, 3955859 (STELLA) 11 May 1976 see column 1, line 62 - column 2,	1,6,11,13,			
A	line 43; figure 1 DE, C, 815283 (KUPFER-ASBEST) 2 August 1951				
	see page 2, lines 19-42; figures	10			
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Form PCT ISA/210 (extra sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 8500188 (SA 8862)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 04/06/85

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent fa member(Publication date
FR-A- 2430555	01/02/80	DE-A- GB-A-	2926207 2030236	17/01/80 02/04/80
FR-A- 2296800	30/07/76	DE-A,B,C GB-A- DE-A,B,C	2500099 1523310 2533751	08/07/76 31/08/78 10/02/77
EP-A- 0065887	01/12/82	FR-A,B US-A-	2505951 4434985	19/11/82 06/03/84
FR-A- 2373003	30/06/78	DE-A- US-A- GB-A- CA-A-	2753170 4171561 1578897 1120071	08/06/78 23/10/79 12/11/80 16/03/82
FR-A- 1508575	. ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	None		
FR-A- 2238875	21/02/75	DE-A- AT-A,B SE-A-	2435675 328815 7409615	.13/02/75 12/04/76 27/01/75
US-A- 3955859	11/05/76	None		
DE-C- 815283		None		